PCT/IB03/04574
15.10.03

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Date of Filing	:	06 NOV 2002
Application Number	:	PCT/SG02/00300 (withdrawn)
Applicant(s) / Proprietor(s) of Patent	:	PHILIPS ELECTRONICS SINGAPORE PTE LTD; KONINKLIJKE PHILIPS ELECTRONICS N.V.
Title of Invention	:	OPTICAL DISK DRIVE APPARATUS, METHOD FOR CONTROLLING THE POSITION OF OPTICAL PICKUP UNIT, METHOD FOR DETECTING AN INNERMOST POSITION OF AN OPTICAL PICKUP UNIT

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22 Sep 2003

Optical disk drive apparatus, method for controlling the position of optical pickup unit, method for detecting an innermost position of an optical pickup unit

This invention relates to an optical disk drive apparatus having a turntable body for rotating a data disk, an optical pickup unit (OPU), means for moving the optical pickup unit for reading a data disk while the disk is being rotated, and means for determining an innermost position of the optical pickup unit corresponding. The invention also relates to a method of controlling the position of an optical pickup unit in an optical disc drive apparatus having a turntable body. This invention further relates to a method for detecting an innermost position of an optical pickup head in an optical disc drive apparatus having a turntable body. Examples of optical disk drive apparatuses are e.g. a CD (compact disc) drive apparatus, an MD (mini disc) drive apparatus, or a DVD (digital versatile disc) drive apparatus.

Embodiments of an optical disk drive apparatus and a method as described in the opening paragraph are known from United States Patent US 6,320,824 B1. The prior-art device includes an optical pickup unit. When a data disk is placed in the device, the optical pickup unit starts to read out information from the disk. The prior-art device includes an innermost position switch connected to a microcomputer. When the optical pickup head reaches its innermost position, the body of the head encounters a control arm of the innermost position switch and changes the switch to its ON state. In this case, a microcomputer is informed that the innermost position switch changes to its ON state. The change of the innermost position switch to its ON state indicates that the optical pickup unit reaches its innermost position. The microcomputer reverses the motion of the pick up unit in response to the change of the innermost position switch to its ON state. Accordingly, when the optical pickup unit reaches its innermost position, the motion is reversed so that the optical pickup unit stops and then starts to move back toward its outermost position. This conventional device and method, however, requires many components such as a switch, connectors, screws etc.

It is an object of this invention to provide a simple device and method of controlling the position of an optical pickup unit and a simple method for detecting.

To this end the device in accordance with the invention is characterized in that the device comprises a means for rotating the turntable body at a speed lower than the operating speed, means for moving the optical pickup unit towards an innermost position, and means for sensing a change in speed as the optical pickup unit contacts the turntable body, and means for producing an indication signal in response to said sensing of said change.

The method in accordance with the invention is characterized in that the turntable body is rotated at a speed lower than the operating speed, the optical pickup unit is moved towards an innermost position, and a change in speed as the optical pickup unit contacts the turntable body is sensed, and an indication signal is produced in response to said sensing of said change.

The invention is based on the following basic principle:

Before reading the data disc, the turntable body is rotated at a relatively low speed, and the optical pickup unit is moved towards an innermost position. When the optical pickup unit contacts the turntable body, an increase in friction of the turntable occurs, which will slow down the turntable. The device is provided with means, e.g. electronics in or near the turntable or a computer program, with which the slowing down is measurable, e.g. in the tacho signal. The device has means which produce an indication signal, which indicates that the optical pickup unit is at the innermost position. Subsequently the motion of the optical pickup unit is reversed, the optical pickup unit is moved outward. The TOC (table of content) may be read and the servo may cut in to take over the control system as in conventional devices and methods. The invention eliminates the components and electronics for the switch, and all the assembly processes and components associated with the switch.

Preferably the optical pickup unit comprises a friction pad to provide friction between the optical pickup unit and the turntable body. Such a friction pad improves the efficiency of the device and method.

Preferably the indication signal is derived from the tacho signal. Standard turntable bodies electronics provide for a tacho signal (a signal indicative of rotational speed of the turntable body). Friction will change the rotational speed of the turntable body and thereby of the tacho signal, which can be taken as indicative of contact, and thus of the fact that the optical pickup unit has reached the innermost position. Owing to the simplicity, the new invention is applicable, with only minor adjustments, to existing designs.

In addition, in the embodiments wherein a friction pad is used, the friction pad may help to reduce the total spin down time.

Within the concept of the invention a 'means for rotating' and "means for moving" as well as "means for sensing", "means for producing is" to be broadly understood and to comprise e.g. any piece of hard-ware (such a rotator, motor, sensor), any circuit or sub-circuit designed for performing or aiding in a rotation, movement, sensing, signal production as described as well as any piece of soft-ware (computer program or sub program or set of computer programs, or program code(s)) designed or programmed to perform an action in accordance with the invention as well as any combination of pieces of hardware and software acting as such, alone or in combination, without being restricted to the below given exemplary embodiments. In embodiments more than more than one means may be combined into one piece of hardware or software.

FIG. 1 is a schematic design of a portion of a prior-art CD player.

FIG. 2 is a schematic representation of another prior art design.

FIG. 3 is a schematic top view of a device in accordance with the invention.

FIG. 4 schematically illustrates a measurement scheme for a tacho signal.

The figures are not drawn to scale. Generally, identical components are denoted by the same reference numerals in the figures.

A prior-art device will be explained below for a better understanding of this invention. FIG. 1 shows a portion of the prior-art CD player comprising an optical pickup unit 1, a motor 2, a lead screw 3, and a guide shaft 4.

The optical pickup head 1 can move along a direction indicated by the double headed arrow hereafter also called the traverse direction between an innermost position and an outermost position with respect to a disc (a data disc, for instance a compact disc, that is, a CD) placed in the device. The guide shaft 4 extends along the traverse direction. The optical pickup head 1 has a portion engaging the guide shaft 4. The optical pickup head 1 is guided by the guide shaft 4 during its movement in the traverse direction.

The optical pickup head 1 includes an engagement portion 1a having a threaded hole through which the lead screw 3 extends.

The engagement portion 1a meshes with the lead screw 3. The lead screw 3 is coupled to an output shaft of the traverse motor 2 via a gear train so that the lead screw 3 can be rotated by the traverse motor 2. As the lead screw 3 rotates, the optical pickup head 1 moves in the traverse direction.

A disc is, in operation, held in position on a turntable body 5. Then, the optical pickup head 1 is moved to its innermost position.

The prior-art CD player of FIG. 1 includes an innermost position switch 6 of a push type near an end of the guide shaft 4. When the optical pickup head 1 reaches its innermost position, the body of the head 1 encounters a control arm of the innermost position switch 6 and changes the switch 8 to its ON state. Accordingly, the change of the innermost position switch 6 to its ON state indicates that the optical pickup head 1 reaches its innermost position. The innermost position switch 6 includes a return spring which urges the control arm. The return spring causes the innermost position switch 6 to be normally in its OFF state.

The innermost position switch 6 has a pair of a fixed contact and a movable contact. The movable contact is connected with and disconnected from a fixed contact in accordance with movement of the control arm of the switch 6. When the optical pickup head 1 assumes its innermost position, the body of the head 1 engages the control arm of the innermost position switch 6 so that the movable contact of the switch 6 touches a fixed contact thereof. Accordingly, in this case, the innermost position switch 6 changes to its ON state. When the optical pickup head 1 moves out of its innermost position, the body of the head 1 separates from the control arm of the innermost position switch 6 so that the movable contact of the switch 8 is disconnected from the fixed contact thereof. Accordingly, in this case, the innermost position switch 6 changes to its OFF state.

The prior-art CD player includes a control circuit 7. The innermost position switch 6 is connected to the control circuit 7. The control circuit 7 is connected with the motor 2. The control circuit 7 regulates that, when the optical pickup unit reaches its innermost position, the motion is reversed so that the optical pickup unit stops and then starts to move back toward its outermost position. This conventional device and method, however, requires many components such as a switch, connectors, screws etc.

Figure 2 illustrates a second example of a prior art device. In this figure the laser L and the disk D are indicated. In this example the switch is located below the optical pickup unit. Although there are a few differences between the designs as shown in figures 1 and 2, both designs require many components such as a switch, connectors, screws etc.

Figure 3 illustrates a device in accordance with the invention. The control circuit 7 comprises a circuit or a program for rotating the turntable body 5 at a low speed while the optical pickup is moved towards the innermost position. Contact between the optical pickup unit and the turntable unit, in this preferred embodiment via a friction pad 8 on the optical pickup unit causes the rotational speed of the turntable body 5 to decrease changing the tacho signal. The change in the tacho signal is detected by the control circuit and a signal I_{idnic} which indicates that the optical pickup unit is at the innermost position is produced. This signal may be produced within the control unit which control unit then controls the motion of the motor 2, or as in this example, the signal I_{indic} is sent to the electronics in or near the motor 2, which reacts to this signal. The motion of the optical pickup unit is reversed, and the optical pickup unit is moved outward. The TOC (table of content) may be read and the servo may cut in to take over the control system as in conventional devices and methods. The invention eliminates the components and electronics for the switch, and all the assembly processes and components associated with the switch.

Fig. 4 illustrates very schematically a measurement scheme for measuring the tacho signal and regulating the speed of the motor 5. The motor 5 is controlled by a motor driver 41. A tacho sensor S is provided for measuring the rotational speed of the motor (or a corresponding physical quantity). The tacho sensor provides a tacho signal 42. This signal 42 is in comparator C compared to a target speed signal 43, thus comparing the actual speed to a target speed. The difference signal is amplified in gain stage G, send to a modulator MOD, which sends a signal to the motor driver 41. In this manner the speed of the motor is regulated to equal the target speed. In this example the tacho speed signal 42 is sent to a micro controller 44. When the micro controller 44 senses a decrease of the tacho speed, as contact is made between the optical pickup unit and the turntable body, an indicative signal I_{indic} is produced. The microcontroller can sense such a decrease by e.g. comparing the tacho speed signal 42 to a gauge speed signal, which is e.g. somewhat smaller than the target speed signal. The decrease can also be measured by measuring the differential of the tacho signal. At contact a relatively large differential d(tacho speed)/dt will be apparent. In embodiments the difference signal supplied by comparator C can also be used to sense a sudden change in the tacho speed. The indicative signal I_{indic} is in such embodiments e.g. produced when the difference signal is larger than a particular value, indicating a sudden decrease of the rotational speed of the turntable body.

In short the invention can be described by:

An optical disk drive apparatus comprises a turntable body (5) for rotating a data disk, an optical pickup unit (1), a motor (2) for moving the optical pickup unit, and means for determining an innermost position of the optical pickup unit. The turntable body is rotated at a speed lower than the operating speed, the optical pickup unit is moved towards an innermost position. A change in speed as the optical pickup unit (1) contacts the turntable body (5) is measured, and an indication signal (I_{indic}) in response to said change is produced. The indication signal is used to reverse the motion of the optical pickup unit.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. For instance in the drawings devices are shown in which the optical pickup unit is moved along shafts. In other embodiments the optical pickup unit may be provided on a swing arm. The invention is then equally applicable. The means for moving the optical pickup unit, in such embodiments, comprises the swing arm.

The invention resides in each and every novel characteristic feature and each and every combination of characteristic features. Reference numerals in the claims do not limit their protective scope. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements other than those stated in the claims. Use of the article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

The present invention has been described in terms of specific embodiments, which are illustrative of the invention and not to be construed as limiting. The invention may be implemented in hardware, firmware or software, or in a combination of them. Other embodiments are within the scope of the following claims.

CLAIMS:

1. An optical disk drive apparatus having a turntable body for rotating a data disk, an optical pickup unit, means for moving the optical pickup unit for reading a data disk while the disk is being rotated, and means for determining an innermost position of the optical pickup unit, characterized in that the device comprises a means for rotating the turntable body at a speed lower than the operating speed, means for moving the optical pickup unit towards an innermost position, and means for sensing a change in speed as the optical pickup unit contacts the turntable body, and means for producing an indication signal in response to said sensing of said change.

2. An optical disk drive apparatus as claimed in claim 1, characterized in that the optical pickup unit, comprises a friction pad.

3. A method of controlling the position of an optical pickup unit in an optical disc drive apparatus having a turntable body, characterized in that the turntable body is rotated at a speed lower than the operating speed, the optical pickup unit is moved towards an innermost position, and a change in speed as the optical pickup unit contacts the turntable body is sensed, and an indication signal is produced in response to said sensing of said change.

4. A method for detecting an innermost position of an optical pickup head in an optical disc drive apparatus having a turntable body, characterized in that the turntable body is rotated at a speed lower than the operating speed, the optical pickup unit is moved towards an innermost position, and a change in speed as the optical pickup unit contacts the turntable body is sensed, and an indication signal is produced in response to said sensing of said change.

5. A method as claimed in claim 3 or 4, characterized in that contact between the optical pickup unit and the turntable body is made via a friction pad.

ABSTRACT:

An optical disk drive apparatus comprises a turntable body (5) for rotating a data disk, an optical pickup unit (1), a motor (2) for moving the optical pickup unit, and means for determining an innermost position of the optical pickup unit. The turntable body is rotated at a speed lower than the operating speed, the optical pickup unit is moved towards an innermost position. A change in speed as the optical pickup unit (1) contacts the turntable body (5) is measured, and an indication signal (I_{indic}) in response to said change is produced. The indication signal is used to reverse the motion of the optical pickup unit.

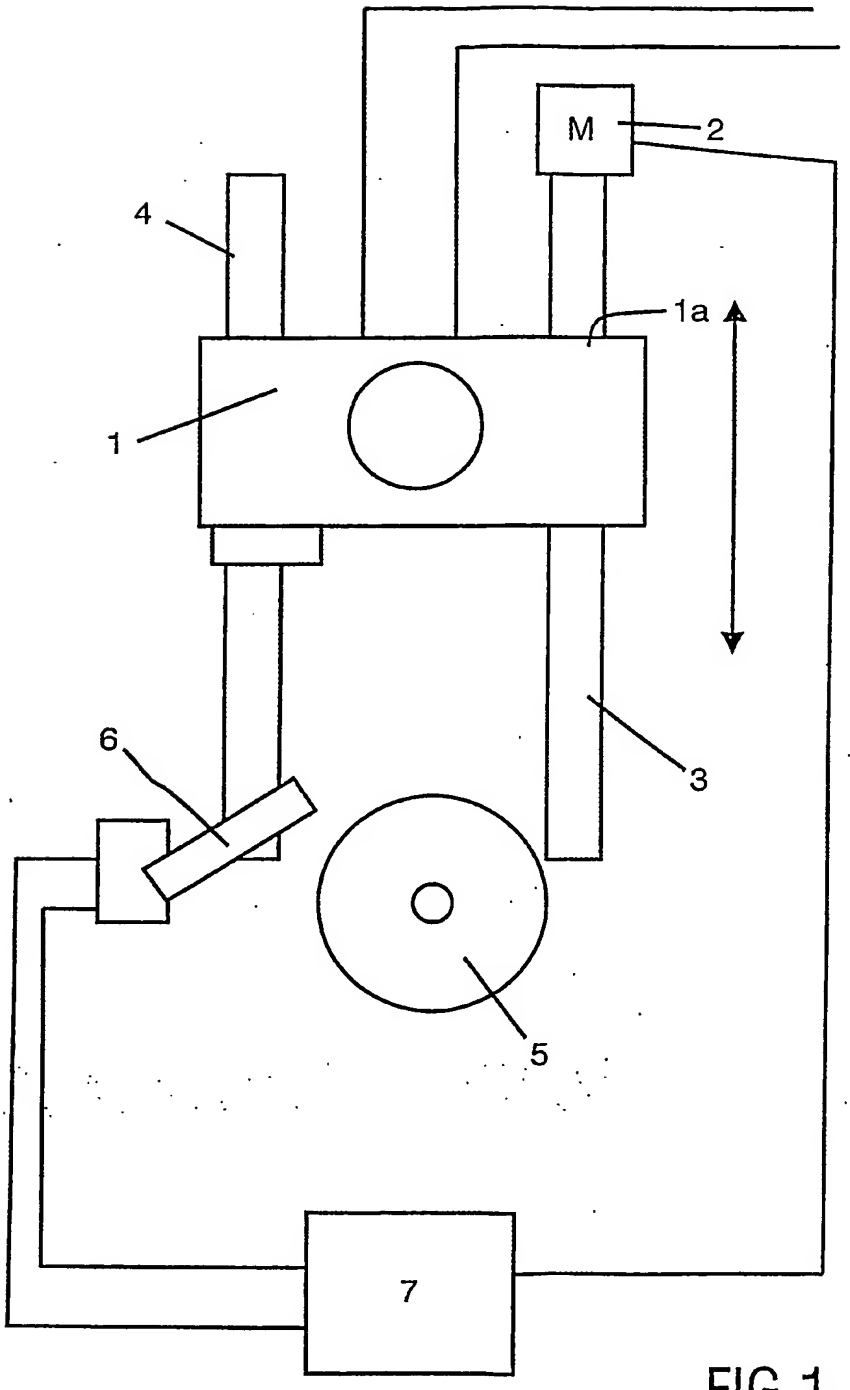

FIG.1

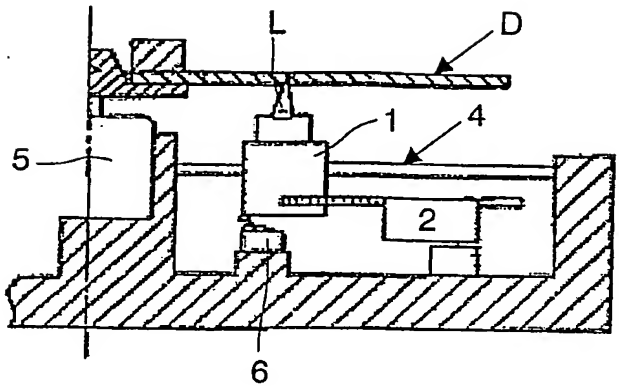

FIG.2

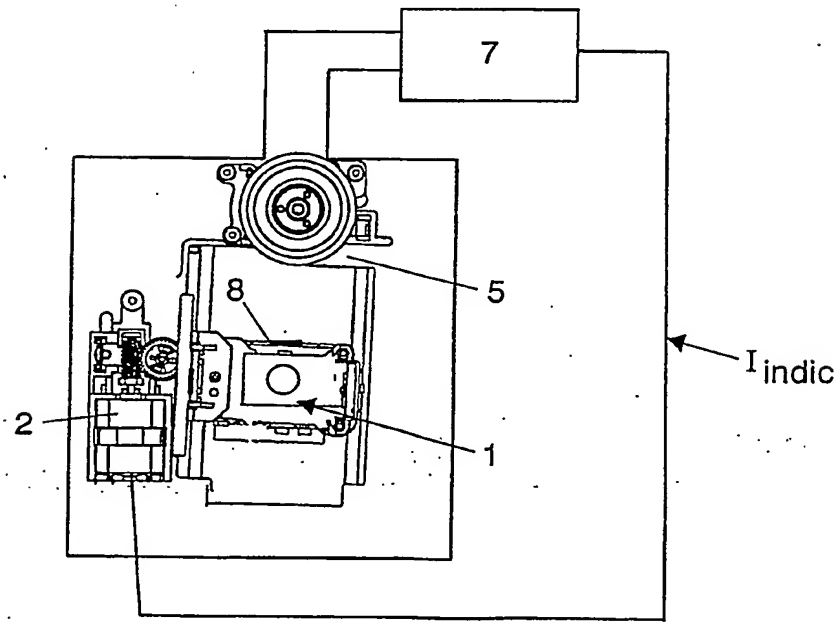

FIG.3

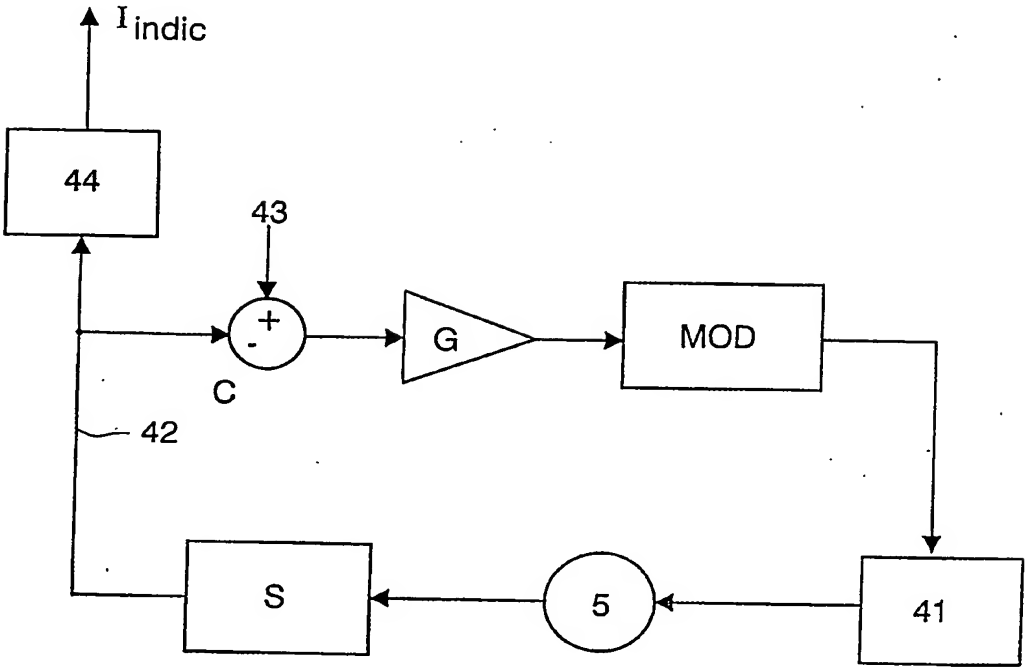

FIG.4